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EFFECTS OF TEACHING ON HOSPITAL COSTS

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I. INTRODUCTION

Much of medical education, especially during the residency, takes place in hospitals. For years, policymakers have been concerned both about the effect of teaching on hospital costs and, once the size of this effect is known, how it should be financed. How much of the cost of medical education should be borne by students as opposed to society at large through third party reimbursement and/or direct government subsidy of education?

To answer the first question, policy analysts have often resorted to the use of log diaries and questionnaires in futile attempts to isolate teaching time of both teacher and student[1] from time allocated to other pursuits.[2] Patient care, teaching, and research are jointly produced in teaching hospitals, and there is no unambiguous way to identify the amount of time devoted to each.

An alternative approach to determine the cost of teaching is to compare hospital costs in teaching versus nonteaching hospitals. Although straightforward conceptually, meaningful comparisons are not easily done in practice. First, to isolate a teaching effect, one must hold other factors constant. Among these other factors, patient casemix is probably the most important since teaching hospitals have always argued (with some justification) that their comparatively high costs reflect the severity of the cases they tend to treat. Until recently, no adequate casemix measures have been available. Second, the dependent cost variable should include payments to all hospital inputs, but hospital cost measures typically capture only a small fraction of payments to physicians for patient care performed in the hospital. Since there is reason to believe that this omitted compensation varies systematically with a hospital's teaching status, empirical results based on a dependent cost variable that excludes these payments may be very misleading. The same problem exists to a lesser extent when the dependent variable is a measure of service intensity. Output levels of ancillary services tend to be comparatively well-measured by hospitals, but hospital data systsems rarely record information on physician contacts with hospitalized patients, except in individual patient charts. Third, if overall cost differences between teaching and nonteaching hospitals can be identified, policymakers and third party payers also want to know where in the hospital such differences arise and their relationship to the level and nature of the teaching effort. Not only does a more in-depth examination increase the plausibility of the overall findings, but also this type of information can be used by hospital rate-setting programs for reimbursement purposes. For example, how does medical education affect nursing expense? Is non-clinical expense affected? Does the teaching effect depend on the nature of the hospital's affiliation with a medical school? Are services more costly in departments with residency programs?

This study presents cost and output functions estimated from a national sample of 367 non-federal, short-term general hospitals that subscribed to both the American Hospital Association's Hospital Administration Service (HAS), the Commission on Professional and Hospital Activities' (CPHA) Professional Activity Study (PAS) in 1974 and 1977, and the AHA's 1972-73 Survey of Medical Staff Organization (MEDORG) in late 1972-73. Merging these data bases with the AHA's Annual Surveys of Hospitals for 1974 and 1977 into a national file permits more thorough empirical analysis of teaching-nonteaching hospital differentials than has been possible before.

Section II provides a capsule description of findings from past reseach. Section III describes our data and empirical specification. Estimated cost functions for the whole hospital, cost and output functions for ancillary service departments, and a summary of estimated effects of teaching on costs in selected departments which do not use physicians are presented in Section IV. The latter two sets of estimates in particular contribute to understanding teaching-nonteaching cost and output differentials because we include measures of physician compensation when appropriate.

II. LITERATURE REVIEW

Effects of Teaching on Hospital Costs

Assessments of hospital costs associated with teaching have been based on comparisons of costs between teaching and nonteaching services of the same hospital (Martz and Ptakowski, 1978), between teaching and a standard of "appropriateness" (Griner and Liptzin, 1971), as well as the time accounting procedures briefly described above. Results from these studies are illustrative rather than definitive. They do not control for a number of factors related to teaching; nor are the hospital samples representative. However, unlike more sophisticated multivariate studies, they offer insights into sources of the teaching-nonteaching cost differential. For example, Busby, *et al*. (1972), suggested five reasons for higher costs in teaching settings: higher indigent patient load; higher outpatient clinic output; lower occupancy rate; greater use of diagnostic services; and higher nursing expense. Martz and Ptakowski (1978) stressed greater volume of laboratory tests and, to a lesser extent, supplies and X-rays. Busby, *et al*. (1972), found that lab tests and X-rays per case were almost twice as high in a medical center than in three community hospitals. Comparing a major teaching and a local proprietary hospital, Schroeder and O'Leary (1977) concluded that increased frequency of diagnostic tests in the teaching hospital accounted for 56 percent of the difference in charges between these two hospitals.

Although multivariate studies have often obtained significant differences between costs or output in teaching and nonteaching settings, these differences are much smaller than in the descriptive comparisons mentioned above. One group of studies defines hospital costs, output, and teaching status for the entire hospital. Lave, Lave and Silverman (1972) found a weak association between higher hospital costs and teaching. Lave and Lave (1970) showed that teaching hospitals in Pennsylvania experienced a higher rate of cost inflation between 1962 and 1967. Carr and Feldstein (1967) used a national sample of 3,147 short-term general hospitals in 1963. They observed higher costs per resident or intern, but negative or mixed effects of medical school affiliation. Salkever (1970), however, found that costs rise as the ratio of medical students to cases increases. Pauly (1978) obtained significant teaching effects on costs in regressions where hospitals with interns-residents were identified by a dummy variable. Sloan and Steinwald (1980) found that medical school affiliation raises hospital costs per adjusted patient day and per admission by 14 and 15 percent, respectively. Sloan and Becker (1981) defined three teaching variables: T1 = 1 for a hospital with interns-residents but no medical school affiliation; T2 = 1 for a hospital affiliated with a medical school but not the Council of Teaching Hospital (COTH); and T3 = 1 for COTH hospitals. Another dummy variable identified hospitals with some funded medical research. Teaching effects were less than half Sloan and Steinwald's; the largest coefficient was for T2. However, research coefficients were statistically significant. Adding the research to T2 and T3 coefficients produces about the same teaching effects as reported by Sloan-Steinwald.

Both Pauly (1978) and Hamilton and Jensen (1979) analyzed hospital costs by department; neither study had an assessment of teaching effects as an important objective. Pauly did not include a teaching variable in his department regressions, and Hamilton-Jensen defined teaching for the hospital as a whole rather than for the department (when appropriate) and did not distinguish among hospitals on the basis of their commitment to teaching.

For purposes of this inquiry, the above studies share some common deficiencies. First, they exclude most payments to physicians for their hospital work.[3] Second, with one exception, the teaching variables do not capture important variations in the level of teaching activity at the institution. Third, except for the descriptive studies, there is no indication why observed cost differentials arise.

Two studies have specifically included payments to physicians in cost analysis, and they merit special attention for this reason. Hosek and Massell (1976) examined the effect of teaching on costs in radiology departments in Veteran's Administration (VA) hospitals. The cost equation estimated for the ith hospital's radiology department is

$$\text{Cost}_i = \sum_j \alpha_j Q_{ij} + \sum_j \beta_j R_i Q_{ij} + \gamma R_i$$

Q_{ij} = quantity of jth radioloy procedure produced in ith hospital's radiology department

R_i = number of residents in ith hospital's radioloy department

The coefficients α_j should be positive, indicating that total cost increases with output for all hospitals in the sample. Those hospitals with residents should have additional salary costs reflected by the positive coefficient γ, but the marginal cost of output may be lower in hospitals with more residents. This tendency would be shown by negative β_j coefficients.

The authors obtained positive α_j and γ, as expected. Generally, the β_j were negative. Quantitatively, they found residents reduce total radiology department cost for the typical VA hospital.

Hosek and Massell's regression equation can be criticized for including an endogenous variable, residents. In addition, it excludes prices of inputs such as physicians and nurses. Thus, their estimated equation cannot be a cost function, since it is well known that cost functions must be homogeneous in degree one in input prices (Christensen and Greene, 1976). Also, there is a danger of generalizing about teaching impacts from a sample of radiology departments in VA hospitals.

On the other hand, Hosek and Massel's departmental cost variable fully captures the cost of attending physicians, since the VA employs only salaried physicians. The dependent variable employed by other reseachers (with the exception of Hamilton and Jensen) confounds departmental costs with methods used to compensate attending physicians. This problem occurs because payments to physicians compensated by fee-for-service typically are not billed through the hospital (Steinwald, 1980). Thus, recorded costs in departments that rely on fee-for-service compensation understate the true cost of providing care, which includes payments to attending physicians. At best (meaning that the error in the dependent variable is uncorrelated with explanatory variables in the cost function), this problem causes the t-statistics of estimated coefficients to be biased toward zero. If, as seems more likely (see Feldman, Sloan, and Paringer, 1981), the chosen compensation method depends on some of the same explanatory variables as cost, then the estimated coefficients in the cost function will be biased as well.

Neu (1976) analyzed data covering all admissions of Medicaid patients to five Albuquerque, New Mexico hospitals from September 1971 through December 1974. One of the hospitals was a major university-affiliated teaching hospital; the other four had low levels of or no teaching activity. Neu classified inpatient episodes into 47 categories based on the patient's primary diagnosis. Each of the 47 was analyzed separately. Holding other factors constant, Neu found that total costs of inpatient episodes, including Medicaid payments to physicians, were 10 to 12 percent lower in the teaching hospital than in the nonteaching institutions. Payments for separately-billed professional services were 33 percent lower on average in the teaching hospital. Neu attributed this result in part to the fact that house staff, who are paid a salary by the teaching hospital, provide care that attending physicians perform in nonteaching settings. If this finding could be generalized, it would imply that excluding professional fees from costs causes one to systematically overstate the teaching-nonteaching differential. Although the finding and its interpretation is plausible, generalizability is a problem. One reason is that private physicians often avoid Medicaid patients because Medicaid pays less than other insurers and much less than physicians' usual fees.[4] Since reliable estimates of the effect of affilation with a teaching hospital on physicians' gross revenue from hospital care are unavailable,[5] one might argue that Neu's finding is caused by physicians' aversion to Medicaid patients.[5]

A different approach to the problem of teaching costs would be to calculate the "replacement cost" of residents, based on the value of residents' time devoted to patient care activities. Freymann and Springer (1973) applied this method to one hospital and found costs would increase if its teaching program were eliminated. While this method has obvious problems, e.g., how to allocate residents' time if learning and patient care are joint products, it is interesting that the net effect of teaching on costs was so small.

The Freymann-Springer finding suggests the following question: why should graduate medical education have any effect on hospital costs? After all, residency training is quite general, since the trained specialist can work in many hospitals or office practices. In other industries, firms will provide general training only if all costs are paid by the employee (Becker, 1975). This analysis suggests that the costs of residency training can be approximated by the difference in income between residents and a suitably-selected cohort of general practitioners.[6] Feldman and Yoder (1980) used this method to estimate that the cost of residency training is about $100,000--somewhat less for pediatrics and more for surgery. If residents pay this entire cost, as predicted by the general training hypothesis, the reported effect on hospital costs would indeed be zero.

Casemix

There is now ample evidence that casemix is an important determinant of inter-hospital variation in average cost, utilization of ancillary services, and mean length-of-stay (Berry (1970), Evans (1971), Evans and Walker (1972), Feldstein (1967), Feldstein and Schuttinga (1977), Thompson, et al. (1975), Olowokure (1978), and Pauly (1978)). Although it is difficult to say that one casemix measure is necessarily superior, failure to include casemix in hospital cost analysis clearly leads to serious omitted variables bias. Since teaching status and casemix are highly and positively correlated, teaching effects on cost and output per case could be greatly overstated if casemix differences were not recognized.

Early work by economists in the hospital field (a decade or so ago) used proxies for casemix such as the percent of cases in various departments and characteristics of the hospital, including affiliations and facilities-services. The authors of these studies recognized that their measures were far from ideal, but they were limited by available data. Feldstein (1967) measured casemix by the percentage of cases within each of eight medical-surgical departments. As Wolfe and Bentkover (1978) recognized, this classification scheme permits a substantial amount of variation within each category. For example, within obstetrics-gynecology, a patient may be admitted for a D and C, a normal delivery, or an abdominal hysterectomy. Certainly there is a considerable amount of variation in resource requirements associated with these three procedures. Within-group heterogeneity of this type can cause biases in estimated parameters. Berry (1970) used approvals-facilities-services (AFS) measures to represent casemix. Although readily available on a hospital basis, the AFS measure is deficient in that it is represented by binary rather than continuous variables, and the large number of such variables needed to adequately depict casemix is a source of multicollinearity.

More recent studies have used diagnostic measures of casemix. Clearly, one problem with the use of AFS also applies to diagnostic measures, namely the large number of diagnoses. Three approaches have been employed to reduce the number of diagnoses needed to adequately describe a hospital's casemix: factor analysis; AUTOGRP (defined below); and an index with diagnosis-specific charges as weights.

Thompson, et al. (1975), employed a patient classification system, AUTOGRP. This system groups patients into diagnostic categories based on significant differences in hospital resource use, considering such additional factors as age-sex, presence of emergency, and complications. In the application of Thompson, et al. , the measure of resource use is length-of-stay. Data on diagnosis were available for 18 Connecticut hospitals in the authors' sample. Using AUTOGRP, the authors reduced the number of diagnostic groups to 35. Clearly, with 18 hospitals, this was far too many. However, the authors found they could explain 87 percent of the variation in special service costs with 4 of 35 groups--arthritis and rheumatism; chemical substances and other trauma; acute appendicitis, etc.; and fractures, dislocations, and sprains.

Pauly (1978) defined a casemix index for hospital j as

$$C_j = \sum_i (\omega_i \cdot \frac{X_{ij}}{X_j})$$

where X_{ij} = number of discharges in hospital j in diagnostic category i;

X_j = total number of discharges in hospital j;

ω_i = ratio of the mean charge for diagnosis i in all hospitals to overall mean charge for all diagnoses in all hospitals

This index has at least two distinct advantages. First, it conserves degrees-of-freedom when used as an explanatory variable. Second, it employs prior information on relative resource requirements of specific diagnoses. This could also be a disadvantage in some instances, for example, if hospitals generate surpluses on some diagnoses (e.g., appendectomies) to subsidize others (e.g., burn unit patients). Use of an index involves a "bet" that, even though isolated instances of price distortions can be found, they are not sufficiently serious to distort the ranking of relative casemix severity among hospitals.

A casemix index, conceptually identical to Pauly's, the "Resource Need Index" (Ament, 1976a, 1976b), has been developed by the CPHA from PAS discharge data. The advantage of RNI, this study's casemix measure, is that it can be provided by PAS on a hospital-by-hospital basis and for a national sample of hospitals. The RNI is based on charges associated with treatment of different illnesses, defined by a matrix of 351 diagnoses, five age groups, and the presence or absence of surgical treatment yielding a total of 3,490 possible cells. Weights for each cell were developed by CPHA from data on charges to 1.8 million patients in 50 hospitals. To construct the RNI for a hospital, each of the hospital's patients is assigned the index value for the relevant cell. The sum of the index values for all patients divided by the number of patients yields the RNI for the hospital.

Watts and Klastorin (1980) found a 0.97 simple correlation between the RNI and an index derived from AUTOGRP diagnostic categories, weighted by average costs per category in a sample of New Jersey hospitals. As the authors noted, "Given that these two variables were determined independently, this unusually high correlation was quite unexpected."(p. 361) This result suggests that the two indices should have similar effects in a hospital cost function. In fact, the standardized regression coefficients we computed from their results (0.30 for RNI and 0.36 for the AUTOGRP-based index) are quite similar.

III. DATA AND SPECIFICATION

Data

So far, our discussion has identified important criteria for empirical analysis of effects of teaching on hospital costs and output.

(1) Payments to physicians should be included in costs.

(2) The nature and level of teaching activity varies both among and within hospitals. Thus, the sample should include a number of hospitals, and there should be some analysis on a departmental basis.

(3) Casemix differences and other cost determinants should be controlled.

Basic information on hospital costs, output, and characteristics comes from the American Hospital Association's (AHA) Annual Surveys of Hospitals (ASH). Our source for department costs and output is Hospital Administrative Services (HAS), a hospital consulting service under the auspices of the AHA. About 2,000 hospitals (reasonably well-distributed by size and teaching status) belong to HAS. The source of HAS information is monthly data submitted by participants according to instructions in the HAS Guide for Uniform Reporting (1976). HAS released data from 1974 and 1977 on selected clinical and service departments to us, and we developed annual estimates from the monthly data. Physicians are not found in nursing and such service departments as dietary and plant operations, and thus there is no concern for physician compensation there. But the physician input does matter in clinical, pathology, and radiology departments. The HAS data include physician compensation if compensation passes through the hospital. However, the conditions under which this occurs are not spelled out, and we have performed imputations on physicians' income to create a data set containing total compensation. Since compensation of physicians in hospital-based specialties of pathology and radiology is far more likely to be handled by the hospital than is true of other physician fields, we limit our departmental analysis to pathology and radiology and to departments in which physicians play no role.

We have examined HAS data on payments to pathologists and radiologists on a hospital by hospital basis. Physician payment data were often lacking when physicians in the department had no contractual relationship with the hospital. We also screened the compensation data for "reasonableness." For each hospital, we had information on the method or methods used by the hospital to compensate pathologists and radiologists from the AHA's Survey of Medical Staff Organization (MEDORG) as well as the number of doctors in each compensation category.[7] If total payments were judged too low, given physician staffing levels in the department, the HAS estimate was replaced. Although the rest of the analysis is based on 1974 and 1977, our analysis of pathology and radiology cost and output is limited to 1974 because, whereas the 1974 HAS and the MEDORG are only a year apart, rather dramatic changes in physician compensation could have occurred between 1973 and 1977.

In brief, the cross-checking and imputation process involved three steps. First, for checking, we removed residents' salaries from reported physician compensation. (This amount was later added back to the physician payment estimate).[8] Second, the remaining compensation figure from the HAS was matched against physician staffing patterns from the MEDORG. When the comparison yielded anomalous results or if no compensation was reported, we proceeded to the third step. Here we combined estimates of mean gross physician income by compensation method and specialty derived from a 1978 U.S. Health Care Financing Administration survey of physicians[9] and information on physician staffing by department and compensation method from the MEDORG. Three compensation methods are listed in the MEDORG survey: salary; other contractual arrangements (mainly percentage arrangements); and fee-for-service. We converted the income estimates from the HCFA survey into 1974 dollars to match the 1974 HAS data. Imputations of payments to physicians were required in 22 percent of the pathology and 42 percent of the radiology cases. The main drawback of imputing lies in eliminating income variation within the three compensation method groups. However, in cases with imputations, there is still variabilty among hospitals due to differences in physician staffing and in mix of compensation methods employed. A single hospital department may employ more than one compensation method, and our imputation approach recognizes this fact.

There is nevertheless a danger that the imputation process may introduce an error affecting the estimated coefficients of teaching variables. The following safeguards should prevent misleading inferences from this source. First, we examine laboratory and radiology output per case as well as costs. The output measures do not suffer from the same deficiency as cost. As seen below, most of the variation in cost in these departments reflects variation in output per case rather than cost per output. Second, we have included measures of the mix of compensation methods in the departments as explanatory variables in some regressions to determine whether the imputation process could have introduced systematic errors by compensation method that have affected the teaching coefficients. Third, we also estimate regressions which exclude payments to physicians. These are useful for comparison. The New Mexico Medicaid study reviewed above suggests that excluding payments to physicians for hospital care should raise the estimated teaching effect. Fourth, we also gauge teaching effects in departments in which physician payment is not a factor. Thus, although ancillary department costs merit attention for several reasons reviewed below, our views about the cost implications of teaching programs will not be completely influenced by our findings on the two ancillary service departments.

The HAS provides a number of intermediate output measures such as meals served, pounds of laundry processed, and number of dialysis treatments. Many are straightforward, but two in particular require some explanation. Laboratory output is measured in terms of workload units prepared according to instructions in the College of American Pathologists' (CAP) Workload Recording Method for Clinical Laboratories. The CAP uses staff time inputs to convert individual laboratory tests into standard workload units. A procedure taking five minutes receives five units; a procedure taking one minute gets one unit. By contrast, HAS requests separate, simple counts of diagnostic and therapeutic radiology procedures. To convert therapeutic into diagnostic units, we ran a regression with hospital revenue from both types of radiology output as the dependent variable and numbers of diagnostic and therapeutic outputs as explanatory variables. The parameter estimates suggest that one therapeutic procedure is worth 1.13 diagnostic procedures. Using 1.13 as a weight for therapeutic output, we added the two types of output to form a single index. Our laboratory output dependent variable contains more information on procedure complexity (as reflected in revenue) than its radiology counterpart.

Data from PAS provide hospital-specific information on the Resource Need Index and the percentage distribution of patients by expected source of payment--Medicare, Medicaid, Blue Cross, commercial, other insurance, and self-pay (the omitted reference group). Unlike data from other sources, we obtained PAS data for 1974 only. The analysis combining 1974 and 1977 data assumes that casemix and the payer distribution remained reasonably constant between 1974 and 1977. The PAS estimates were derived from individual patient discharge forms aggregated to the level of the hospital for purposes of this research. We had to obtain written permission from each hospital before gaining access to HAS and PAS data.

Compared to the universe of non-federal short-term general hospitals in 1974, our sample underrepresents hospitals with fewer than 100 beds (51 versus 18 percent in our sample), proprietary hospitals--only three in our sample, and state-local government hospitals (28 versus 19 percent in our sample).[10] Our hospitals are quite close to the national distributions by Census Area. Hospitals with medical school affiliations are overrepresented in our sample (10 versus 21 percent for our sample).

Specification

The process by which hospitals set price and output is complicated by their typically nonprofit ownership and the peculiar relationship of a key input, physicians, to hospitals. According to one view, hospital behavior is guided by maximization of quantity and quality, where quality increases with service intensity, subject to a constraint imposed by patients' demand and the nonprofit requirements that total revenue, including funds from nonpatient care sources, equal total cost.[11] If patients' willingness to pay increases, the constraint is relaxed and the hospital can provide additional and more service-intensive care.

The determination of departmental outputs is also a complicated process. Output commands presumably originate at higher levels in the hospital's organizational structure. X-rays and tests are required to treat hospitalized patients. We may think of patients treated as the hospital's "final" output; therefore, the demand for intermediate outputs is derived from the demand for final outputs. However, there may be considerable latitude in the average number of intermediate outputs per treatment, or the "intensity" of services. "Common sense" suggests factors affecting demand for hospital care, such as insurance, should raise service intensity. With a quantity-quality model of hospital behavior, however, this will only be so if certain restrictions are satisfied.[12]

The "classical" approach to cost analysis is a function relating cost (or average cost) to output and factor prices. In studies of regulated industries like electric power (Christensen and Greene (1976), Nerlove (1963)) or railroads (Caves and Christensen (1976), Brown, Caves, and Christensen (1979)), it is typically assumed that output is exogenous. The reason is that price and therefore output is set by an exogenous regulatory process. This assumption cannot be maintained for hospitals, since there is no outside force constraining either final or intermediate hospital output even in states with mandatory rate or revenue regulation. Given this endogeneity problem, we estimate reduced form cost and output functions in which the dependent variables depend on all the exogenous variables in the system. We specify hospital bedsize categories, ownerships, and teaching status as exogenous variables since hospitals are likely to be locked into past decisions affecting these variables for long periods of time.

Table 1 presents concise definitions of our dependent and explanatory variables included in the following tables. Many of the variables have already been described, and most of the others have been employed in previous hospital studies. The variable WAGE measures the price of non-physician personnel. A reasonable objection to using actual non-physician payroll expense per full-time equivalent employee is that any measurement error in this variable will also appear in the cost dependent variable, causing a positive errors-in-variables bias. In regressions not shown, we replaced WAGE with its predicted counterpart generated by instrumental variables. Results were generally similar but the WAGE parameter estimates in the following tables are about 20 percent lower than those for predicted WAGE.

Binary variables describing the hospital do not vary between 1974 and 1977; neither do the variables from PAS, RNI and third party reimbursement. Variables OPD, INC, DEN, and WAGE through Y77 (in Table 1) are year-specific.

IV. EMPIRICAL RESULTS

Hospital Cost Functions

Table 2 presents six estimated cost functions for the hospital as a whole. The first two, for cost per adjusted patient day and per adjusted admission, combine teaching and nonteaching hospitals. The third and fifth are for nonteaching hospitals, defined as T1 through T3 equal to zero, and the fourth and sixth for their teaching counterparts. The latter four regressions allow teaching status to interact with other explanatory varibles whereas, in the first two, the teaching effect is additive.

The pattern of the teaching coefficients in the first two regressions is as anticipated. Just having residents contributes 5.2 and 2.0 percent to mean non-physician expense per adjusted patient day and per adjusted admission, respectively.[13] However, neither T1 coefficient is statistically significant at conventional levels. For T2 hospitals, the corresponding impacts are 9.7 and 5.2 percent, respectively; and for Council of Teaching Hospitals, 19.7 and 13.9 percent. The smaller effect of teaching on cost per admission than on cost per day reflects shorter mean stays in teaching hospitals, _ceteris paribus_.

Although our focus is on teaching, several other results from the first two regressions merit attention. First, there are no cost differences between government and voluntary hospitals. Second, the size variables imply scale economies with cost per adjusted patient day but diseconomies with cost per adjusted admission. Third, casemix, represented by the RNI, has a substantial impact on average cost, especially on cost per case. Fourth, per capita income has a positive effect on per diem cost but none on per case cost. An inference from this pattern is that income influences the amenity level and service intensity, but since length of stay tends to be longer for the poor, in part becaue of lower service intensity, income does not influence cost per case. The omitted reimbursement category is self-pay. The results do not support the view that costs are higher, the higher the proportion of patients with private or public insurance. Rather, these regressions indicate that a high Medicaid patient proportion raises average cost substantially above self-pay whereas hospital costs are much lower when Medicare patients are comparatively numerous. One of us found a similar pattern in a study of hospital utilization on the same sample with the same reimbursement variables and PAS utilization measures as the dependent variables (Becker and Sloan, 1981).

Table 3 provides means of variables from the teaching and nonteaching samples. Teaching hospitals are 21.8 and 33.3 percent higher in non-physician cost per adjusted patient day and per adjusted admission. These differentials are far higher than those implied by the T1 through T3 coefficients in Table 2, which reflect influences of teaching on non-physician expense, holding other factors constant. As seen in Table 3, the RNI is 9.6 percent higher in teaching hospitals; real wages of non-physician personnel are 7.3 percent higher and population density is over six times higher. The teaching institutions depend less on patients whose primary souce of payment is Medicare, commercial insuance, and self-pay (7 versus 10 percent) and more on Medicaid (slightly more), Blue Cross, and insurance from other sources. Teaching hospitals are concentrated in the Northeast, considerably larger, and more likely to be unionized.

Tests of equality between sets of coefficients in the two sets of teaching-nonteaching regressions in Table 2 reject the null hypothesis of no difference between the two types of hospitals at the 10 and 1 percent level, respectively. The most interesting differences between the results for teaching versus nonteaching institutions are as follows. First, although there are differences in the impact of the RNI, no systematic pattern is evident; RNI has a larger effect on per diem cost in teaching hospitals but a smaller one on cost per case. This result is important because a systematic relationship could be a sign of errors in our casemix measure systematically related to teaching. Second, the positive Medicaid effect for all hospitals, mentioned above, exists only for non-teaching hospitals; the Medicaid proportion has no effect on costs in their teaching counterparts. Medicare's negative impact is stronger for teaching than for nonteaching institutions. Third, care in government teaching hospitals is more costly than in corresponding private teaching hospitals but the opposite pattern on ownership applies to non-teaching hospitals. These differences are obscured when the teaching and non-teaching samples are combined.

Cost Output of Ancillary Service Departments

Table 4 presents regressions for output and cost per adjusted admission and cost per unit of output. We have also estimated regressions with patient days in place of admissions; results are similar, so we do not present them here to conserve space. Admissions-based measures command greater interest from policymakers. Unlike other tables, the Table 4 regressions are based exclusively on 1974 data.

By definition, cost per admission equals cost per unit of output times output per admission, or, in natural logarithms:

$$\ln(\frac{\text{COST}}{\text{ADMISSION}}) = \ln(\frac{\text{OUTPUT}}{\text{ADMISSION}}) + \ln(\frac{\text{COST}}{\text{OUTPUT}})$$

It is evident that we can choose any two equations and derive the third as their sum or difference. Although, in principle, it is necessary to present only two out of three, we present all three because a substantial number of cases are lost when the dependent variable is laboratory workload units. It is important to be sure that the change in sample does not substantially alter the parameter estimates. As specified, the sum of coefficients from the first and second should equal the fourth and the sum of the fifth and sixth should equal the eighth. The dependent variables of the third and seventh, PCAMP and RCAMP, refer to non-physician expense per adjusted admission in pathology and radiology whereas their counterparts PCAMT and RCAMT include payments to pathologists and radiologists.

We first focus on effects of teaching. The PCAMT and RCAMT regressions show the "bottom line." Teaching has a substantial effect on total pathology expense per admission, but no corresponding effect is evident for radiology. Lab expenses per case in a COTH hospital with an approved residency program in pathology (T3 and RES = 1) are 32 percent higher than in a hospital with no physician training activity. However, almost all of this difference is attributable to unusually high cost per workload units in such settings. Judging from the LAB regression, such hospitals only generate about three percent more workload units per case than nonteaching institutions. However, the PLAB regression shows a 41 percent differential in pathology expense per workload unit. The contributions of the two components of PCAMT exceed the teaching effect observed from the PCAMT regression itself, but this is to be expected when there is a substantial change in sample size. Results of teaching on utilization for radiology suggest a teaching effect only when the hospital has a residency program in this field. Thus, the utilization results are consistent across the two departments.

Since physician payment data are not generally available from hospital sources, comparisons between expense regressions with and without physician payment data are interesting. Comparing teaching effects from the PCAMP versus the PCAMT regression and between RCAMP and RCAMT, it is evident that when there is a difference, the impact of teaching from the non-physician expense regression is higher. When combined with evidence from past reseach described above, these comparisons add to the impression that observed teaching effects are higher when physician payments are excluded.

The trustworthiness of the estimated teaching impacts depends greatly on our ability to hold other determinants constant. Focusing first on the utilization equations, we see that the casemix index is positive and significant at the one percent level with an elasticity of 1.15 (LAB) and 1.02 (XRAY). With casemix included, the partial correlation between teaching and utilization largely or entirely vanishes. These results clearly indicate that "casemix matters." In fact, casemix is almost the only thing that matters. Due in part to the sample size, the only other significant coefficient is the Medicare variable; Medicaid's coefficient is also negative, but very imprecise. The OPD variable also raises the number of X-ray procedures per case. Though smaller in absolute value, the Medicare proportion coefficient is statistically significant in the XRAY regression.

The RNI has no impact on the unit cost of laboratory services, but exerts a substantial significant effect on its radiology counterpart. This difference reflects the fact that HAS laboratory workload units capture variations in output complexity better than the radiology output measure. Nevertheless, for both departments, the reason that a higher RNI leads to higher non-physician and total departmental expense per case is primarily due to RNI's impact on utilization (rather than to expense per unit of ancillary service output).

Total departmental expense per case is greatly reduced when the hospital has a high proportion of Medicare patients. For laboratory expenses, the difference is attributable to lower utilization by Medicare patients; for radiology, both utilization and expense per output unit are underlying factors. The picture for Medicaid is less clear.

The MCAID parameter estimated in the non-physician expense per case regression is positive and statistically significant, but this relationship disappears when payments to physicians are added to the dependent variable. It appears that where Medicaid patients are numerous, production of lab services is non-physician intensive. This is not surprising in view of low Medicaid fee schedules for physicians' services. The MCAID variable exerts a negative impact on both expense measures for radiology, but the MCAID coefficient on RCAMT is more negative than RCAMP, a pattern consistent with the Medicaid results for laboratory services even if the signs on the coefficients are not. Viewing regression results for both types of services together, it is clear that the positive MCAID coefficients on non-physician expense for the hospital as a whole do not come from these ancillary departments. The source must be elsewhere.

Variables representing the prevalence of methods used to compensate the hospital's medical staff were entered in ancillary department regressions not presented here. These variables only made a statistically significant contribution once, in utilization of radiological services per case (XRAY). They had no meaningful effect on the coefficients on the teaching variables; this strongly suggests that our imputation algorithm did not introduce errors systematically related to hospital teaching activity.

Effects of Teaching on Costs of Nursing and Selected Non-Clinical Departments

Table 5 presents estimated percentage teaching effects for six departments. Payments to physicians are not pertinent to any of these. Although most of the teaching effects are positive for nursing administration and medical-surgical unit nursing, no coefficient underlying a percentage teaching effect is statistically significant at conventional levels. However, COTH hospitals are significantly more costly in terms of per diem pharmacy expense, dietary and plant operations expense per diem and per case, and housekeeping per diem.

Since output measures are available from HAS in some instances, it is sometimes possible to probe a bit further for the source of this cost variation. Since the cost of plant operations and housekeeping is actually less per square foot, we can infer that there is more area to maintain in COTH hospitals. The HAS instructs the responding hospital to include square feet subject to maintenance; it makes no attempt to allocate hospital square footage to particular activities, such as teaching or patient care.

The percentage effects for cost per unit of department output are negative more often than not. This pattern suggests that the high cost per laboratory workload unit is more the exception than the rule. Higher cost per patient day or admission is more often a reflection of more intermediate outputs per day or per case.

V. CONCLUDING REMARKS

The notion that medical education raises the cost of hospital care has long been part of the conventional wisdom. The main reason for this alleged cost incrase is thought to be the extra number of procedures and consultations performed, reflecting both teaching demands and the intrinsic complexity of casemix in teaching hospitals. To the extent that teaching hospitals have a tougher job medically, no one would argue against paying them more per patient day and per case. Whether higher cost due to teaching demand should be reimbursed is much more debatable and no one would want to subsidize pure inefficiency in teaching hospitals. Sorting out these effects has been greatly impeded by lack of data; our data are hardly perfect, but they represent a step forward.

Holding casemix and other factors constant greatly reduces the cost difference attributable to teaching. Non-physician expense in medical school-affiliated, non-COTH hospitals is less than 10 percent higher on average, *ceteris paribus*, than in nonteaching hospitals; the differential is *at most* 20 percent for COTH hospitals.

If billings by physicians for care performed in teaching hospitals are less on average than billings in nonteaching institutions for comparable care, then estimates of the teaching effect from hospital cost data which exclude payments to physicians will be overstated. Past research by Hosek and Massell (1976) and Neu (1976) indicated that when payments to physicians are included, expense in teaching hospitals was no higher, if not lower, than in nonteaching hospitals.

Our results do not show that adding payments to physicians eliminates the differential; but for the ancillary departments, this addition reduces it. Thus, our research implies that the above 10 and 20 percent figures, based on non-physician cost, are indeed upper bounds on the teaching effect on the physician and non-physician cost of hospital care. Furthermore, at least some of the cost difference is found on the non-clinical side in dietary, plant operations, and housekeeping departments. Although third parties may not wish to pay for space used for purposes other than patient care, the process by which such teaching costs are generated is different from the generally-assumed one, namely ordering extra tests and consultations for educational purposes.

While stressing the tentative nature of our findings and the need for further analysis, the results for ancillary departments suggest the following: higher total costs in ancillary departments of teaching hospitals are due primarily to casemix and secondarily to residency teaching demands. One implication is that the debate over how to pay for the cost of teaching is largely irrelevant. Instead, public policy might look at interdepartmental and interdiagnostic subsidies within hospitals. Simple cases within large teaching hospitals may be subsidizing the more complex cases, because high total costs are averaged over all cases, whether they are simple or complex. Another implication is that diagnostic-based reimbursement (payment by DRG or RNI) will probably not hurt and may help teaching hospitals. Some of our results (Becker and Steinwald, 1981) have shown that teaching status significantly affects RNI. Therefore, reimbursement based on RNI may bring third-party payments more in line with the resource needs of teaching hospitals than other reimbursement formulas.

In earlier work[14] and in preliminary phases of this study, we were concerned with the role of physician compensation methods as a factor accounting for interhospital variations in costliness. Results from our past research demonstrated a systematic relationship between type of compensation method and hospital teaching status. Our reseach on ancillary service departments in this study implies that compensation does not matter at all for total department costs in these departments and not generally for service intensity. This suggests that public policy might concentrate on what hospitals produce rather than how they set up the arrangements to produce it.

FOOTNOTES

1. The term "teacher" throughout refers to a teaching physician; all trainees, including residents, are considered students.

2. See, for example, Institute of Medicine (1974).

3. Hamilton and Jensen recognized the physicians' compensation issue. They _excluded_ physicians' salaries from department costs. The other studies simply used reported costs which may or may not include physicians' compensation.

4. See Sloan, _et al_. (1978).

5. The closest study is Pauly's (1980) research on the impact of hospital inputs on physician productivity, but it does not really provide what we need.

6. Costs in the first year of a residency program are equal to the simple income difference between residents and GPs; costs in the second and subsequent years equal the income difference plus the foregone return on previously incurred costs (see Feldman and Yoder, 1980, p. 209).

7. See Feldman, Sloan, and Paringer (1981) for a description of this survey.

8. Residents' salaries are available from American Medical Association directories of graduate medical education.

9. This survey is described by Steinwald (1981).

10. Information on the universe comes from Sloan and Steinwald (1980) and American Hospital Association (1975).

11. See, for example, Feldstein (1971, 1977), Newhouse (1970), and Salkever (1972).

12. Sloan and Steinwald (1980), Chapter 2.

13. The coefficients on binary variables require an adjustment to yield percentage changes. See Halvorsen and Palmquist (1980).

14. Feldman, Sloan, and Paringer (1981), Steinwald (1981), and Sloan and Becker (1981).

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Table 1. Variable Definitions

Dependent Variables:

CPD#	Non-physician cost per adjusted patient day
CAM#	Non-physician cost per adjusted admission
LAB#	Laboratory workload units per adjusted admission
PLAB#	Total pathology department cost per workload unit
PCAMP#	Non-physician pathology department cost per adjusted admission
PAMT#	Total pathology department cost per adjusted admission
XRAY#	Radiology procedures per adjusted admission
PXRAY#	Total radiology department cost per radiology procedure
RCAMP#	Non-physician radiology department cost per adjusted admission
RCAMT#	Total radiology department cost per adjusted admission

Explanatory Variables:

T1*	Approved residency program
T2*	Medical school affiliation
T3*	Member, Council of Teaching Hospitals
RES*	Approved residency program in this department
GOV*	Nonfederal government control
SIZE1*	0-99 beds
SIZE2*	100-249 beds
SIZE3*	250-399 beds
RNI#	Resource Need Index
OPD	Proportion of adjusted patient days that are outpatient visits
INC#	County per capita income
DENS#	County population per square mile
MCARE	Proportion of discharges covered by Medicare
MCAID	Proportion of discharges covered by Medicaid
BLUE	Proportion of discharges covered by Blue Cross
COM	Proportion of discharges covered by commercial insurance
OTH	Proportion of discharges covered by other insurance
WAGE#	Non-physician payroll/Full-time equivalents (hospital or department)
UNION*	Hospital has signed collective bargaining agreement
STRIKE*	Hospital has experienced strike or other work stoppage
Y77*	Year = 1977
NE*	Northeast Census Area
NC*	North Central Census Area
S*	South Census Area

All variables are defined for the whole hospital unless noted.

*Indicates dummy variable equal "1" if definition is met and "0" otherwise.

#Measured as natural logarithm.

The omitted categories for dummy and proportion variables are: insurance (self-pay); teaching status (no approved residency program); size (over 400 beds); control (nongovernment); union status (no union); strike (no strike); Census Area (West).

Table 2. Hospital Cost Functions

Explanatory Variable	Dependent Variable (Sample)					
	1.CPD(W)	2.CAM(W)	3.CPD(NT)	4.CPD(T)	5.CAM(NT)	6.CAM(T)
T1	0.051 (0.032)	0.020 (0.015)	- (-)	- (-)	- (-)	- (-)
T2	0.093^{a} (0.024)	0.051^{b} (0.023)	- (-)	- (-)	- (-)	- (-)
T3	0.18^{a} (0.03)	0.13^{a} (0.03)	- (-)	- (-)	- (-)	- (-)
GOV	0.003 (0.02)	0.007 (0.02)	-0.022 (0.022)	0.073^{b} (0.036)	-0.014 (0.02)	0.047 (0.038)
SIZE1	0.20^{a} (0.03)	-0.057^{c} (0.032)	0.20^{a} (0.05)	- (-)	-0.073 (0.049)	- (-)
SIZE2	0.098^{a} (0.026)	-0.020 (0.025)	0.094^{b} (0.048)	0.10^{a} (0.04)	-0.022 (0.043)	-0.029 (0.04)
SIZE3	0.078^{a} (0.023)	-0.019 (0.022)	0.080^{c} (0.047)	0.056^{b} (0.024)	-0.004 (0.043)	-0.036 (0.025)
RNI	0.61^{a} (0.11)	0.98^{a} (0.10)	0.63^{a} (0.16)	0.80^{a} (0.13)	1.16^{a} (0.14)	1.01^{a} (0.14)
OPD	0.075 (0.16)	-0.33^{b} (0.16)	-0.27 (0.21)	0.38 (0.24)	-0.62^{a} (0.19)	0.11 (0.26)
INC	0.17^{a} (0.052)	0.013 (0.05)	0.17^{a} (0.07)	0.085 (0.089)	-0.030 (0.06)	0.12 (0.10)
DENS	0.033 (0.006)	0.053^{a} (0.006)	0.022^{a} (0.009)	0.067^{a} (0.009)	0.035^{a} (0.008)	0.10^{a} (0.01)
MCARE	-0.82^{a} (0.21)	-0.49^{b} (0.20)	-0.62^{a} (0.29)	-1.50^{a} (0.34)	-0.58^{a} (0.26)	-0.86^{b} (0.36)
MCAID	0.29^{c} (0.16)	0.29^{c} (0.15)	0.63^{a} (0.22)	-0.17 (0.20)	0.54^{a} (0.20)	-0.00 (0.22)
BLUE	-0.005 (0.13)	-0.16 (0.12)	0.19 (0.18)	-0.27 (0.17)	0.001 (0.16)	-0.31^{a} (0.18)
COM	0.23^{c} (0.13)	-0.36^{a} (0.12)	0.45^{a} (0.17)	-0.065 (0.18)	-0.30^{c} (0.16)	-0.34^{c} (0.19)
OTH	-0.030 (0.121)	-0.22^{c} (0.12)	0.16 (0.17)	-0.37^{b} (0.17)	-0.23 (0.15)	-0.26 (0.19)
WAGE	0.57^{a} (0.06)	0.36^{a} (0.06)	0.65^{a} (0.08)	0.39^{a} (0.09)	0.35^{a} (0.07)	0.30^{a} (0.10)
UNION	-0.000 (0.02)	0.008 (0.02)	-0.007 (0.026)	0.009 (0.024)	0.011 (0.02)	0.000 (0.03)
STRKE	0.036 (0.035)	0.040 (0.033)	0.049 (0.052)	0.013 (0.04)	0.010 (0.047)	0.063 (0.048)
Y77	0.18^{a} (0.02)	0.17^{a} (0.01)	0.18^{a} (0.02)	0.19^{a} (0.02)	0.17^{a} (0.02)	0.18^{a} (0.02)
NE	-0.28^{a} (0.03)	-0.080^{a} (0.031)	-0.24^{a} (0.04)	-0.27^{a} (0.05)	-0.096^{b} (0.040)	-0.007 (0.05)
NC	-0.20^{a} (0.02)	0.019 (0.023)	-0.21^{a} (0.03)	-0.14^{a} (0.04)	-0.002 (0.03)	0.093^{b} (0.047)
S	-0.22^{a} (0.03)	-0.041^{c} (0.025)	-0.24^{a} (0.03)	-0.14^{a} (0.04)	-0.068 (0.03)	0.040 (0.049)
CONS	-1.98 (-)	3.33 (-)	-2.79 (-)	0.47 (-)	3.90 (-)	2.75 (-)
	R^2=0.63 F(23,761) =55.2	R^2=0.67 F(23,756) =67.9	R^2=0.58 F(20,500) =34.4	R^2=0.66 F(19,244) =24.7	R^2=0.56 F(20,500) =31.6	R^2=0.66 F(19,239) =24.5

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a = Statistically significant at one percent level (two tail test).
b = Statistically significant at five percent level (two tail test).
c = Statistically significant at 10 percent level (two tail test).
W = Whole sample; T = Teaching sample; NT = Non-teaching sample.

Table 3. Variable Means: Teaching versus Nonteaching Hospitals

Variable	Sample	
	Teaching	Nonteaching
CPD	$131.	$108.
CAM	$1065.	$768.
GOV	0.14	0.19
SIZE1	0.00	0.24
SIZE2	0.09	0.48
SIZE3	0.36	0.28
RNI	1.03	0.94
OPD	0.12	0.12
INC	$4522.	$4194.
DENS	$3236.	$495.
MCARE	0.18	0.21
MCAID	0.08	0.06
BLUE	0.31	0.24
COM	0.25	0.32
OTH	0.11	0.07
WAGE	$8682.	$8089.
UNION	0.30	0.19
STRKE	0.06	0.03
Y77	0.53	0.48
NE	0.35	0.12
NC	0.35	0.42
S	0.20	0.27
No. of obs.	264	521

Table 4. Utilization and Cost Regressions: Pathology and Radiology

Explanatory Variable	Dependent Variable Pathology		Radiology					
	1.LAB	2.PLAB	3.PCAMP	4.PCAMT	5.XRAY	6.PXRY	7.RCAMP	8.RCAMT
T1	0.18 (0.13)	0.18 (0.013)	0.16^b (0.08)	0.099 (0.072)	-0.005 (0.073)	0.068 (0.083)	0.025 (0.078)	0.085 (0.083)
T2	0.18 (0.13)	-0.15 (0.13)	0.090 (0.071)	0.065 (0.064)	-0.019 (0.056)	0.036 (0.040)	0.030 (0.059)	0.037 (0.064)
T3	0.26^c (0.15)	-0.032 (0.15)	0.21^b (0.10)	0.12 (0.09)	-0.10 (0.08)	0.015 (0.089)	-0.041 (0.08)	-0.043 (0.088)
RES	-0.23^c (0.13)	0.38^a (0.13)	0.13^c (0.07)	0.16^b (0.06)	0.11^c (0.07)	0.037 (0.078)	0.20^a (0.07)	0.10 (0.07)
GOV	0.11 (0.08)	-0.097 (0.077)	0.025 (0.042)	-0.013 (0.039)	-0.017 (0.037)	0.045 (0.043)	0.059 (0.039)	0.014 (0.04)
SIZE1	-0.22 (0.14)	0.58^a (0.15)	0.053 (0.079)	0.18^a (0.07)	0.056 (0.073)	0.026 (0.084)	-0.004 (0.008)	0.081 (0.082)
SIZE2	-0.15 (0.12)	0.38^a (0.12)	0.043 (0.063)	0.11^b (0.06)	0.041 (0.054)	-0.005 (0.062)	0.029 (0.038)	0.039 (0.063)
SIZE3	-0.11 (0.11)	0.26^b (0.11)	0.030 (0.057)	0.056 (0.051)	0.041 (0.051)	-0.022 (0.058)	0.085 (0.054)	0.028 (0.059)
RN1	1.15^a (0.40)	-0.31 (0.41)	1.19^a (0.26)	1.31^a (0.23)	1.02^a (0.23)	0.60^b (0.26)	1.78^a (0.23)	1.57^a (0.25)
OPD	2.02^a (0.64)	-1.88^a (0.65)	0.86 (0.41)	0.69^c (0.38)	1.62^a (0.36)	-1.14^a (0.41)	0.99^b (0.38)	0.89^b (0.40)
INC	0.21 (0.26)	0.080 (0.27)	-0.068 (0.15)	0.054 (0.14)	-0.055 (0.14)	0.17 (0.16)	0.25^c (0.14)	0.073 (0.16)
DENS	0.001 (0.02)	0.042 (0.027)	0.038^a (0.015)	0.026^c (0.014)	0.038^a (0.014)	-0.014 (0.016)	0.042^a (0.014)	0.040^b (0.016)
MCARE	-1.26 (0.97)	-0.13 (1.01)	0.037 (0.052)	-0.91^c (0.47)	-0.78^c (0.46)	-0.95 (0.61)	-1.67^a (0.47)	-1.65^a (0.55)
MCAID	-0.62 (0.88)	-0.13 (0.91)	1.20^a (0.43)	0.32 (0.39)	-0.47 (0.41)	-0.26 (0.54)	-0.49 (0.39)	-0.89^c (0.46)
BLUE	-0.72 (0.68)	-0.47 (0.72)	0.83^a (0.29)	-0.072 (0.27)	0.24 (0.29)	-0.47 (0.43)	0.064 (0.27)	-0.17 (0.34)
COM	-1.05 (0.73)	-0.28 (0.75)	0.71^b (0.30)	-0.16 (0.27)	-0.077 (0.30)	-0.51 (0.45)	-0.10 (0.27)	-0.43 (0.35)
OTH	-0.97 (0.66)	-0.21 (0.69)	0.58^b (0.29)	-0.22 (0.26)	-0.11 (0.28)	-0.62 (0.41)	-0.27 (0.26)	-0.65^b (0.33)
WAGE	0.19 (0.22)	0.21 (0.23)	0.50^a (0.13)	0.46^a (0.12)	0.035 (0.09)	0.42^a (0.11)	0.42^a (0.10)	0.48^a (0.10)
NE	0.11 (0.12)	-0.12 (0.12)	-0.13 (0.08)	-0.10 (0.08)	0.12 (0.07)	-0.21^b (0.08)	-0.038 (0.075)	-0.14 (0.08)
NC	0.046 (0.092)	0.007 (0.10)	-0.072 (0.056)	-0.003 (0.05)	0.21^a (0.05)	-0.23^a (0.06)	0.004 (0.05)	-0.065 (0.058)
S	-0.02 (0.10)	0.088 (0.10)	-0.086 (0.059)	-0.054 (0.054)	0.067 (0.052)	-0.13^b (0.06)	-0.084 (0.056)	-0.073 (0.13)
CONS	2.91 (-)	-4.15 (-)	-1.02 (-)	-0.53 (-)	0.98 (-)	-1.57 (-)	-2.39 (-)	-0.70 (-)
	R^2=0.45 F(21,104) = 4.0	R^2=0.35 F(21,103) = 2.6	R^2=0.49 F(21,278) = 12.8	R^2=0.43 F(24,274) = 8.6	R^2=0.42 F(21,260) = 9.1	R^2=0.29 F(21,256) = 4.9	R^2=0.55 F(21,299) = 17.9	R^2=0.39 F(21,295) = 8.9

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a = Statistically significant at one percent level (two tail test).
b = Statistically significant at five percent level (two tail test).
c = Statistically significant at 10 percent level (two tail test).

Table 5. Teaching Effects: Selected Hospital Departments

	Department Cost per			Percent Effect** Teaching Variables		
Department	Adj.Pat.Day	Adj. Adm.	Unit of Output	T1	T2	T3
Nursing administration	X*			8.3	6.8	12.7
Nursing administration		X		4.2	5.9	9.1
Med.-surg. nursing	X			4.6	-1.3	5.6
Med.-surg. nursing		X		-0.4	-5.4[c]	4.1
Pharmacy	X			0.4	2.9	12.6[b]
Pharmacy		X		2.2	1.7	9.1
Dietary	X			4.2	2.9	13.1
Dietary		X		0.6	1.6	9.0[c]
Dietary (meals)			X	-2.8	-4.6[b]	4.5
Plant operations	X			4.6	9.3[b]	25.3[a]
Plant operations		X		0.2	7.8[c]	20.3[a]
Plant operations (sq. ft.)			X	-11.0[c]	-8.1[c]	-5.4
Housekeeping	X			3.3	6.3	12.2[b]
Housekeeping		X		-0.3	4.9	8.2
Housekeeping (sq. ft.)			X	-16.1[a]	10.8[a]	-7.8
Laundry	X			-10.1	3.3	-2.0
Laundry		X		-7.1	8.0	1.1
Laundry (lbs.)[d]			X	-19.7[a]	-9.9[c]	-11.3

Notes:

a = Statistically significant at one percent level (two tail test).

b = Statistically significant at five percent level (two tail test).

c = Statistically significant at 10 percent level (two tail test).

d = Only includes inhouse laundry (excludes contracted laundry).

* An "X" designates the dependent variable to which the estimated teaching effects apply.

**If there is no designation, the teaching effect is insignificant.

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